DSPMC v2 – pn 7762S, 7762M

Ethernet Motion Controller
Data Acquisition System
PID Controller

User Guide

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Phoenix, AZ USA

For more information please visit the product web page:
www.vitalsystem.com/dspmc

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License Agreement

Before using the DSPMC and accompanying software tools, please take a moment to go thru this License agreement. Any use of this hardware and software indicate your acceptance to this agreement.

It is the nature of all machine tools that they are dangerous devices. In order to be permitted to use DSPMC on any machine you must agree to the following license:

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I fully accept all responsibility for the operation of this machine while under the control of DSPMC, and for its operation by others who may use the machine. It is my responsibility to warn any others who may operate any device under the control of DSPMC board of the limitations so imposed.

I fully accept the above statements, and I will comply at all times with standard operating procedures and safety requirements pertinent to my area or country, and will endeavor to ensure the safety of all operators, as well as anyone near or in the area of my machine.

WARNING: Machines in motion can be extremely dangerous! It is the responsibility of the user to design effective error handling and safety protection as part of the system. VITAL Systems shall not be liable or responsible for any incidental or consequential damages. By Using the DSPMCv2 motion controller, you agree to the license agreement.

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Overview

The DSPMC is an Ethernet based controller for motion control, data acquisition, and general PID control system applications. Utilizing the latest DSP technology, the DSPMC offers a comprehensive set of features for your demanding applications.

DSPMC controller can be applied in a variety of applications involving PC based Motion Control, Storage and Retrieval Systems and CNC Milling / Lathe Machines. Equipped with a rich set of hardware interfaces, it can also be used for wide variety of applications involving PID control, e.g., speed, oven temperature control and so on.

Following in the key features of DSPMC v2:

- 8 Channels Servo Drive Analog Outputs, Range ±10V, 16-Bit Resolution
- 8 Step and Direction Channels up to 4MHz Step Frequency
- 16 Differential Quadrature Encoder Inputs. 32-Bit Resolution (Upper 9 channels shared with Digital Inputs)
- 4 MHz Max Encoder frequency. Encoder resolution multiplied by 4 thru Hardware.
- 8 Channel Analog Inputs, Range ±10Volts, 16-bit Resolution (7762M Only)
- 96 Digital I/O (64 Inputs & 32 Outputs)
- Ethernet 100Mb connectivity using TCP/IP interface.
- Wide input power range 10-40VDC
- Simple UDP Socket Programming Interface.
- Visual Studio 2010 .Net Managed Library for C#, C++, and VB.Net Software Developers.
- Standalone Operation by programming the unit with BASIC programming language.

Extremely Important Reminder

When operating machines, take extreme precautions. The machines can have enormous power even with a small motor. Never come inside a machine path while powered. Operating machines without necessary precautions can result in lost of limbs or even death.

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Software Components

The DSPMC comes with GUI software tools for Hardware Testing, setup PID controller, run motion control commands, and upgrade new firmware. Following gives a brief description of the software tool set:

All software components including the Mach3/Mach4 plugins may be downloaded from the DSPMC webpage.

VSI Device Manager

In order to change or update the firmware installed on the DSPMC, or activate features, you will have to install the VSI Device Manager application. For instructions on using the program, see the provided manual.

Extended Features:

- **Macro Programming** – Unlocks the use of dspMacro Programs for standalone operation. See "VSI Macro Loader" for more information

- **Scan and Trigger** – Unlocks the dspMacro and the Scan and Trigger function which allows toggling the state of a Digital Output when a certain Analog Input Voltage threshold is reached. Must be set using a dspMacro program.

VSI Macro Loader

VSI Macro Loader is an application that is used to install and debug dspMacro Programs on the DSPMC controller. The user can select the dspMacro file (.bas file) and download it to the controller. "PRINT" statements in the code can be viewed in the output window after launching the dspMacro program.

Custom Software Application with DSPMC

Custom Windows applications can be created using the **VSI Motion Control API** library. The Library is an API designed to allow communication (via Ethernet) using commands to arm/disarm, control and read I/O, and command motion among others. Sample applications and a user guide may be found here.

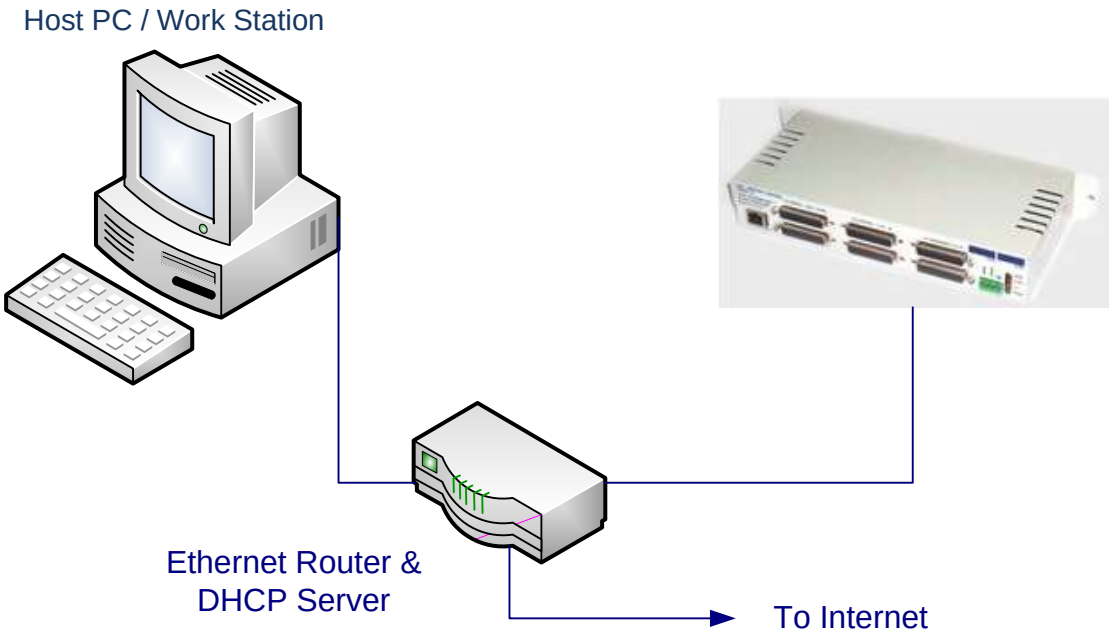
Network Connection Setup

You can connect the DSPMC board directly to your PC or connect via an Ethernet switch or router. The DSPMC board can use the firmware pre-assigned IP address, ie, 192.168.0.50, or it can get a unique IP address from an external DHCP server on your network. In the latter case, the firmware pre-assigned IP address is ignored.

There are two ways to setup the IP addresses of your PC and the DSPMC board:

1. Using a Router with DHCP Server
2. Manually assigning an IP Address to your PC

Setup IP address using a Router with DHCP Server



The figure above shows a basic setup using a router on your network. Connect the Ethernet cable from the J1-Ethernet port of the DSPMC board to the DHCP server/Router. Connect another Ethernet cable from the DHCP Server/Router to the PC. The DHCP server dynamically assigns IP address both to the PC as well as to the DSPMC board, and therefore completes the network setup without requiring any intervention from the user.

Note: If your network device does not support Auto-MDIX feature, a crossover Ethernet cable may be required.

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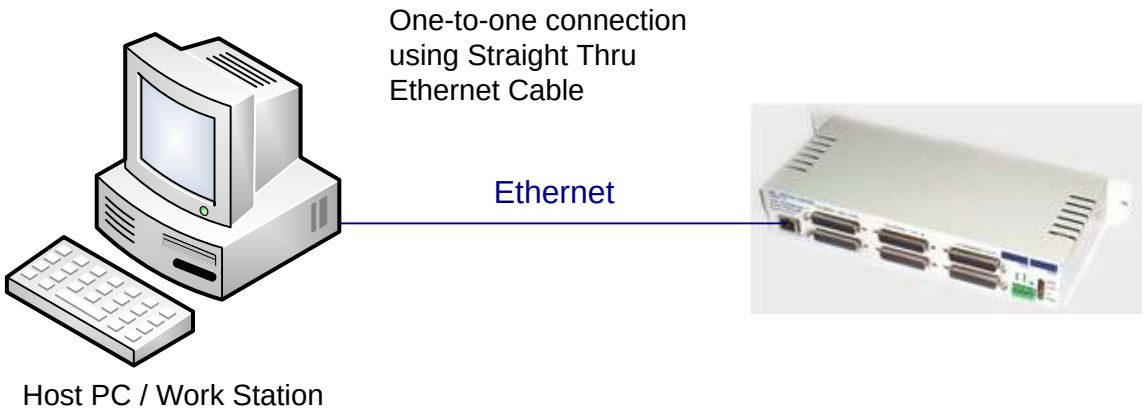
Manually assigning an IP Address to the PC

With TCP/IP networking, the PC and the DSPMC, both, need their own unique IP address.

When connecting the PC directly to the DSPMC board, you will need to manually assign an IP address to your PC. The DSPMC board will use its firmware pre-assigned IP address, i.e., 192.168.0.50.

The Ethernet cable is connected from the J1-ethernet port of the DSPMC board to the PC as shown below:

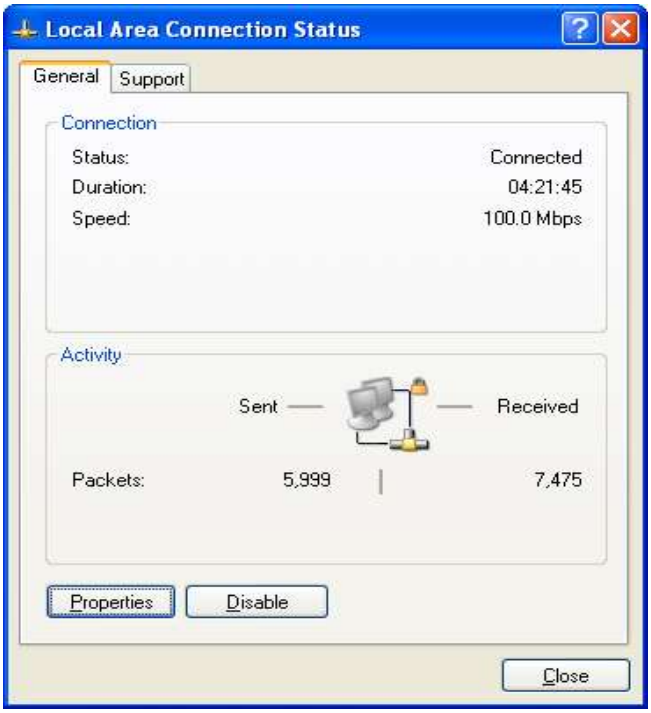


The PC IP Address can be configured manually in windows XP as follows. For other operating systems, please consult the respective user guides for changing the IP address.

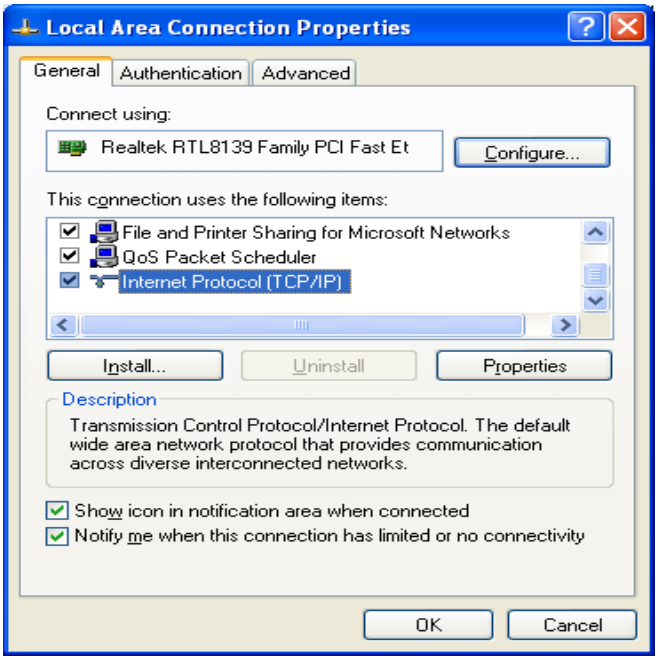
NOTE: Instructions for configuring Windows 7 PCs can be found here. **Skip to STEP 4 afterwards**

1. Double click on the 'My Network Places' icon in Windows XP and open the 'available network connections'.

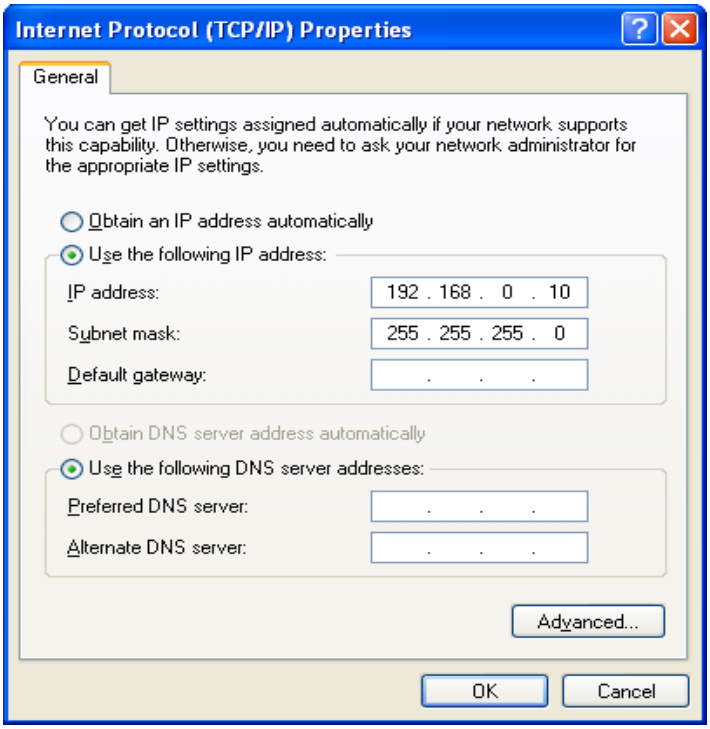
2. Double click on the corresponding LAN Connection over which the device will be setup. The following window appears.



3. Click on the Properties and select the Internet Protocol (TCP/IP) Connection in 'General' Tab

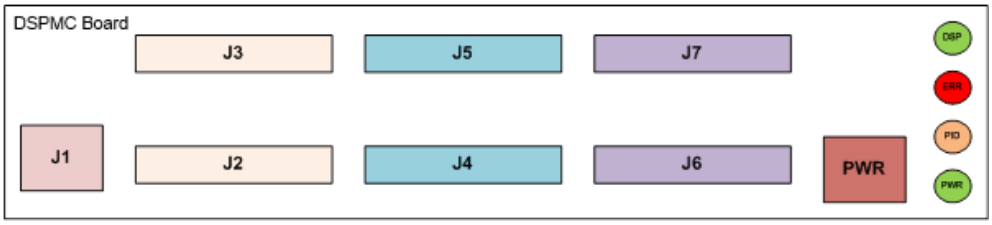


4. Click on the ‘Properties’ button and make the settings in your PC similar to the one shown in the figure below. After settings are done, click ‘OK’ button to finish the setup


Internet Protocol (TCP/IP) Properties
General
You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.
Obtain an IP address automatically
Use the following IP address:
IP address:
192 . 168 . 0 . 10
Subnet mask:
255 . 255 . 255 . 0
Default gateway:
Obtain DNS server address automatically
Use the following DNS server addresses:
Preferred DNS server:
Alternate DNS server:
Advanced...
OK
Cancel

Hardware Interface description

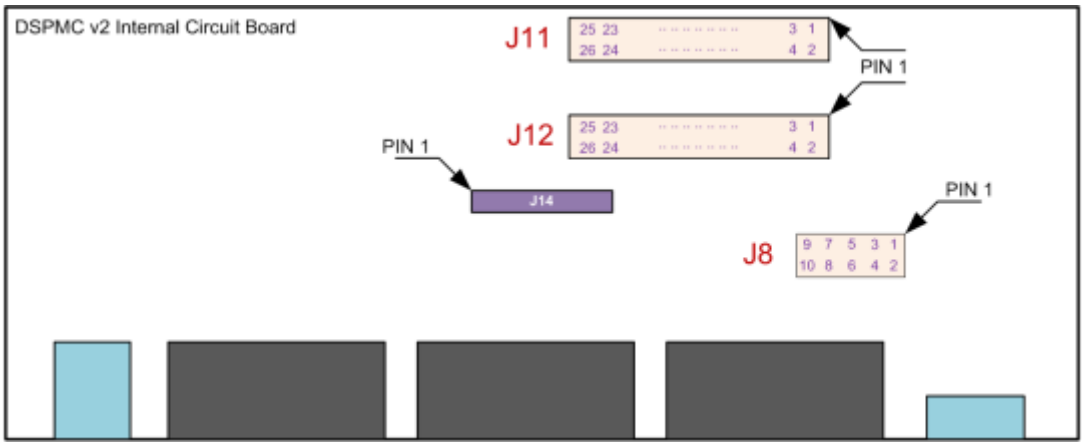
The DSPMC board has several interface ports and indicator LEDs. Figure below shows front side view of the DSPMC board with interface ports and other components:



J1 – Ethernet port connected to PC
J2 – Provides analog input and DAC output
J3 – Stepper Motor outputs, Differential Encoder Input (Index 6).
J4 – Digital I/Os, provide 16 inputs (0 to 15) and 8 outputs (0 to 7)
J5 – Digital I/Os, provide 16 inputs (16 to 31) and 8 outputs (8 to 15)
J6 – Differential Encoder inputs (Index 0, 1 and 2).
J7 – Differential Encoder inputs (Index 3, 4 and 5)
PWR – Power Connector

PWR LED – Green colored LED for Power indication; it glows steadily when Power is on
PID LED – Orange colored LED for PIDs in-control; it glows steadily when PID is armed
ERR LED – Red colored LED for error indication.
DSP LED – Green colored LED indicating DSP processor operation; blinks constantly during normal operation.

There are a few connectors available on the internal circuit board, which are accessible by opening the top cover, or the ribbon cable slot:



J11 – Digital I/Os, provide 16 inputs (32 to 47) and 8 outputs (16 to 23)
J12 – Digital I/Os, provide 16 inputs (48 to 63) and 8 outputs (24 to 31)
J8 – Differential Encoder Channel Input (Index 7).
J14 – Stepper Step and Direction Output Channels 6 and 7 (**3.3Volts** signals)

Ethernet Port - J1

Connect to PC directly or via an Ethernet Hub or a switch. The DSPMC board supports both 10 MBit and 100 Mbit network speeds. TCP/IP network protocol in UDP mode is used for PC communications.

Analog I/O Port – J2

J2 Pin Assignments:

Pin#	Function	Pin#	Function
1	+12V, 100mA max	20	Analog Input 0
14	+5V, 500mA max	8	Analog Input 1
2	-12V, 50mA max	21	Analog Input 2
15	Analog Output 0	9	Analog Input 3
3	Analog Output 1	22	Ground (return)
16	Analog Output 2	10	Analog Input 4
4	Analog Output 3	23	Analog Input 5
17	Ground (return)	11	Analog Input 6
5	Analog Output 4	24	Analog Input 7
18	Analog Output 5	12	Ground (return)
6	Analog Output 6	25	Ground (return)
19	Analog Output 7	13	+5V, 500mA max
7	Ground (return)		

- **Analog Inputs** (Available on **7762-M** Models Only)
  - Input voltage Range: **-10 to +10 Volts**.
  - Input impedance: 10M Ohm.
  - Binary Resolution: 16 bits
  - Conversion Rate: up to 20KHz

- **Analog Outputs**
  - Analog Output range: +/-10 Volts.
  - Analog Output Resolution: 16 Bits
  - Maximum Output Current Per Output: 20mA

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Step and Direction Outputs, Encoder Channel #6 on J3 and J14

J3 provides 6 channels Step and Direction Signals, and one differential encoder input. The Step/Dir output signals are 0...5V Range.

J3 Pin Assignments:

Pin#	Function	Pin#	Function
1	Step 0	20	Direction 5
14	Step 1	8	Encoder Channel 6 A+
2	Step 2	21	Encoder Channel 6 A-
15	Step 3	9	Encoder Channel 6 B+
3	Step 4	22	Encoder Channel 6 B-
16	Step 5	10	Encoder Channel 6 X+
4	+5V, 500mA	23	Encoder Channel 6 X-
17	Ground (return)	11	+5V 500mA
5	Direction 0	24	Ground (Return)
18	Direction 1	12	Reserved
6	Direction 2	25	Reserved
19	Direction 3	13	Ground (Return)
7	Direction 4		

J3 can also provide 3 Step and Direction channels as **differential** outputs:

Pin#	Function	Pin#	Function
1	Step 0+	20	Direction 2-
14	Step 0-	8	Encoder Channel 6 A+
2	Step 1+	21	Encoder Channel 6 A-
15	Step 1-	9	Encoder Channel 6 B+
3	Step 2+	22	Encoder Channel 6 B-
16	Step 2-	10	Encoder Channel 6 X+
4	+5V, 500mA	23	Encoder Channel 6 X-
17	Ground (return)	11	+5V 500mA
5	Direction 0+	24	Ground (Return)
18	Direction 0-	12	Reserved
6	Direction 1+	25	Reserved
19	Direction 1-	13	Ground (Return)
7	Direction 2+		

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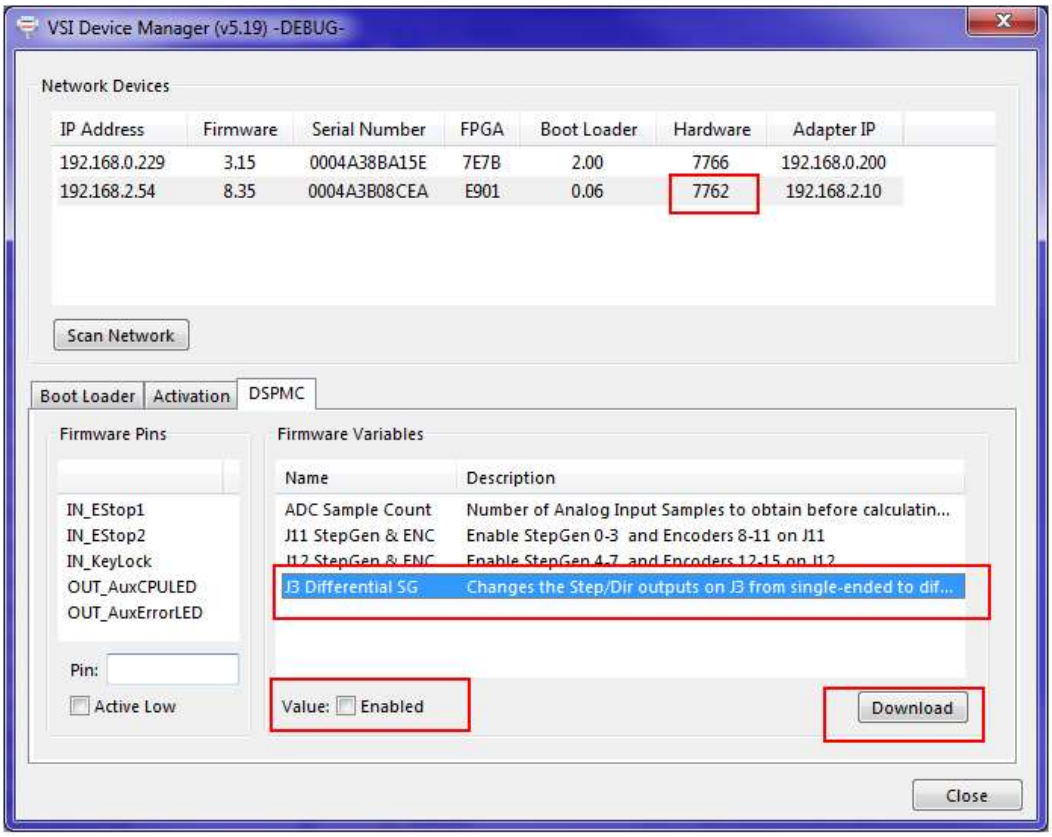
To enable **differential** step and direction outputs on J3, use the VSI Device Manager software and configure the firmware variable as follows:



J14 is a 6 pin header, which is only accessible by opening the top cover. It provides two extra channels of Step/Direction signals. These Stepper channels use the 3.3V standard. Stepper Channels 0..5 are available on J3 outside connector, and use 5 Volts standard.

J14 Pin Assignments:

Pin#	Function
1	+3.3V, 100mA
2	Gnd (Return)
3	Step 6
4	Direction 6
5	Step 7
6	Direction 7

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Digital I/O Ports - J4, J5, J11, J12

On the DSPMC 7762 board, there are Four Digital I/O connectors, each providing sixteen inputs and eight outputs. Total, there are 64 digital inputs and 32 digital outputs.

These Digital I/O plugs are not optically isolated and use low voltage 3.3Volt standard. For 24 Volts operation, you can use the digital I/O breakout board ***pn7535*** with DSPMC board. These boards connect directly to J4, J5, J11 and J12, and provide detachable screw terminals for easy wiring and maintenance. Please visit this webpage for more info on 7535.

The digital inputs are also used for emulated quadrature encoder for low speed applications, e.g. MPG wheel for CNC control. For more details, see section 4.6 Single-Ended Encoder Inputs.

For connecting 24 Volts I/O on J4, J5, J11, and J12, the 7535 (P or N) I/O breakout board should be used. OPTO22 style modules (e.g. G4ODC5 and G4IDC5) can also be used with these ports.

Connecting 24 Volts directly on these plugs may damage the unit.

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J4 Pin Assignments:

Pin#	Function	Pin#	Function
1	Ground (Return)	20	Input 4
14	Output 0	8	Input 5
2	Output 1	21	Input 6
15	Output 2	9	Input 7
3	Output 3	22	Input 8
16	Output 4	10	Input 9
4	Output 5	23	Input 10
17	Output 6	11	Input 11
5	Output 7	24	Input 12
18	Input 0	12	Input 13
6	Input 1	25	Input 14
19	Input 2	13	Input 15
7	Input 3		

J5 Pin Assignments:

Pin #	Function	Pin#	Function
1	Ground (Return)	20	Input 20
14	Output 8	8	Input 21
2	Output 9	21	Input 22
15	Output 10	9	Input 23
3	Output 11	22	Input 24
16	Output 12	10	Input 25
4	Output 13	23	Input 26
17	Output 14	11	Input 27
5	Output 15	24	Input 28
18	Input 16	12	Input 29
6	Input 17	25	Input 30
19	Input 18	13	Input 31
7	Input 19		

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J11 Pin Assignments:

Pin#	Function	Pin#	Function
1	Ground	2	Digital Output 16
3	Digital Output 17	4	Digital Output 18
5	Digital Output 19	6	Digital Output 20
7	Digital Output 21	8	Digital Output 22
9	Digital Output 23	10	Digital Input 32
11	Digital Input 33	12	Digital Input 34
13	Digital Input 35	14	Digital Input 36
15	Digital Input 37	16	Digital Input 38
17	Digital Input 39	18	Digital Input 40
19	Digital Input 41	20	Digital Input 42
21	Digital Input 43	22	Digital Input 44
23	Digital Input 45	24	Digital Input 46
25	Digital Input 47	26	+5V

J12 Pin Assignments:

Pin#	Function	Pin#	Function
1	Ground	2	Digital Output 24
3	Digital Output 25	4	Digital Output 26
5	Digital Output 27	6	Digital Output 28
7	Digital Output 29	8	Digital Output 30
9	Digital Output 31	10	Digital Input 48
11	Digital Input 49	12	Digital Input 50
13	Digital Input 51	14	Digital Input 52
15	Digital Input 53	16	Digital Input 54
17	Digital Input 55	18	Digital Input 56
19	Digital Input 57	20	Digital Input 58
21	Digital Input 59	22	Digital Input 60
23	Digital Input 61	24	Digital Input 62
25	Digital Input 63	26	+5V

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Differential Quadrature Encoders on J6, J7, J3, and J8

J6 Pin Assignments:

Pin#	Function	Pin#	Function
1	Encoder Channel 0 A+	8	+5V 500mA
14	Encoder Channel 0 A-	21	Ground (Return)
2	Encoder Channel 0 B+	9	Encoder Channel 2 A+
15	Encoder Channel 0 B-	22	Encoder Channel 2 A-
3	Encoder Channel 0 Z+	10	Encoder Channel 2 B+
16	Encoder Channel 0 Z-	23	Encoder Channel 2 B-
4	+5V 500mA	11	Encoder Channel 2 Z+
17	Ground (Return)	24	Encoder Channel 2 Z-
5	Encoder Channel 1 A+	12	+5V 500mA
18	Encoder Channel 1 A-	25	Ground (Return)
6	Encoder Channel 1 B+	13	Reserved
19	Encoder Channel 1 B-		
7	Encoder Channel 1 Z+		
20	Encoder Channel 1 Z-		

J7 Pin Assignments:

Pin#	Function	Pin#	Function
1	Encoder Channel 3 A+	8	+5V 500mA
14	Encoder Channel 3 A-	21	Ground (Return)
2	Encoder Channel 3 B+	9	Encoder Channel 5 A+
15	Encoder Channel 3 B-	22	Encoder Channel 5 A-
3	Encoder Channel 3 Z+	10	Encoder Channel 5 B+
16	Encoder Channel 3 Z-	23	Encoder Channel 5 B-
4	+5V 500mA	11	Encoder Channel 5 Z+
17	Ground (Return)	24	Encoder Channel 5 Z-
5	Encoder Channel 4 A+	12	+5V 500mA
18	Encoder Channel 4 A-	25	Ground (Return)
6	Encoder Channel 4 B+	13	Reserved
19	Encoder Channel 4 B-		
7	Encoder Channel 4 Z+		
20	Encoder Channel 4 Z-		

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J3 Pin Assignments:

Pin#	Function	Pin#	Function
1	Step 0	20	Direction 5
14	Step 1	**8**	**Encoder Channel 6 A+**
2	Step 2	**21**	**Encoder Channel 6 A-**
15	Step 3	**9**	**Encoder Channel 6 B+**
3	Step 4	**22**	**Encoder Channel 6 B-**
16	Step 5	**10**	**Encoder Channel 6 X+**
4	+5V, 500mA	**23**	**Encoder Channel 6 X-**
17	Ground (return)	**11**	**+5V 500mA**
5	Direction 0	**24**	**Ground (Return)**
18	Direction 1	12	Reserved
6	Direction 2	25	Reserved
19	Direction 3	13	Ground (Return)
7	Direction 4		

J8 Pin Assignments: J8 is a 10 pin header, which is accessible by opening the top cover.

Pin#	Function
4	**Encoder Channel 7 A+**
3	**Encoder Channel 7 A-**
6	**Encoder Channel 7 B+**
5	**Encoder Channel 7 B-**
8	**Encoder Channel 7 X+**
7	**Encoder Channel 7 X-**
2	**+5V 500mA**
1	**Ground (Return)**
9	Unused
10	Unused

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Single-Ended Encoder Inputs

In addition to dedicated hardware encoder inputs, DSPMC board also provide three Single Ended encoder inputs in Digital Input J4 and J5 connector. These are simulated encoder inputs, therefore called, *SoftEncoder*, and are used for low speed applications like MPG. The following table lists the Digital I/O pins assigned to *SoftEncoders*. (Requires Firmware Rev 63 or newer):

SoftEncoder 0: A+ On J4 Pin 24,
B+ On J4 Pin 12

SoftEncoder 1: A+ On J4 Pin 25
B+ On J4 Pin 13

SoftEncoder 2: A+ On J5 Pin 18
B+ On J5 Pin 6

SoftEncoders are normally used as MPG source. See Section 7.11.7 Manual Pulse Generation (MPG) for more information.

In addition, *SoftEncoders* are designed to avoid Jerks when MPG scale is changed by the PC software. To accomplish this, these encoder counters are implemented using floating point numbers (instead of whole integer numbers). They can be assigned decimal values (eg 3.092, 5.001, 64000.5 etc) which the hardware encoder counters are not capable of (they can only take whole integers).

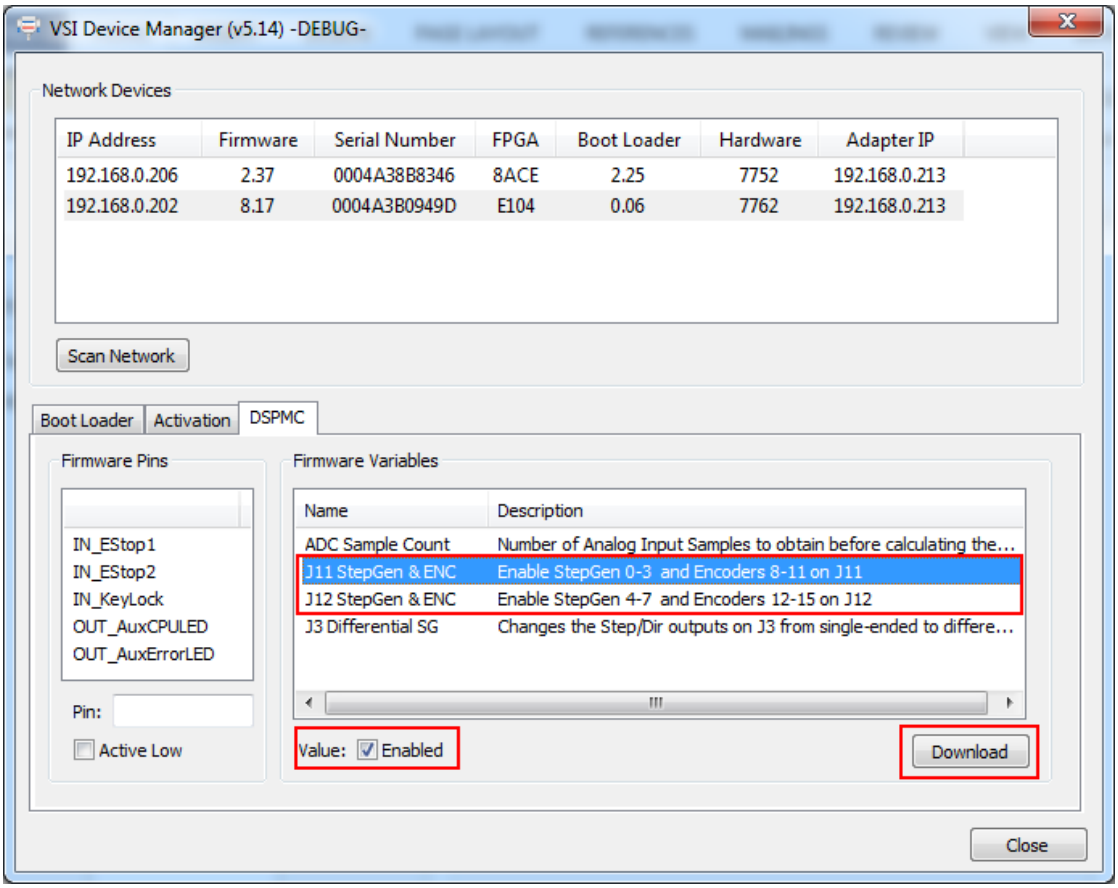
Step and Direction Outputs and Encoder Channels on J11 and J12

The DSPMC supports 8 Step and Direction Channels on ports J3, J11 and J12.

NOTE: *Although ports J11 and J12 are used for Digital I/O, they can be configured to output Step and Direction signals using the VSI Device Manager application. The 7737 board lets you connect encoder and Step/Dir signals to J11 and J12 via RJ45 style plugs.*

Encoder channels 8 – 15 are always active along with the digital inputs on J11 and J12. Encoders and digital inputs share the same pins.

The 7737 Encoder/Stepper Board is designed to be plugged directly into J11 and J12 for 24V optical isolation and RJ45 connectors for differential encoders and differential step and direction signals.



J11 Pin Assignments for Single-Ended Encoders and Step/Dir Output Channels:

Pin#	Function	Pin#	Function
1	Ground	2	Step Signal Channel 4
3	Direction Signal Channel 4	4	Step Signal Channel 5
5	Direction Signal Channel 5	6	Drive Enable Output 20
7	Digital Output 21	8	Digital Output 22
9	Digital Output 23	10	Single-ended Encoder Ch 7 A
11	Single-ended Encoder Ch 7 B	12	Single-ended Encoder Ch 7 Z
13	Single-ended Encoder Ch 8 A	14	Single-ended Encoder Ch 8 B
15	Single-ended Encoder Ch 8 Z	16	Single-ended Encoder Ch 9 A
17	Single-ended Encoder Ch 9 B	18	Single-ended Encoder Ch 9 Z
19	Single-ended Encoder Ch 10 A	20	Single-ended Encoder Ch 10 B
21	Single-ended Encoder Ch 10 Z	22	Single-ended Encoder Ch 11 A
23	Single-ended Encoder Ch 11 B	24	Single-ended Encoder Ch 11 Z
25	Drive Error Input 47	26	+5V

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J12 Pin Assignments for Single-Ended Encoders and Step/Dir Output Channels:

Pin#	Function	Pin#	Function
1	Ground	2	Step Signal Channel 6
3	Direction Signal Channel 6	4	Step Signal Channel 7
5	Direction Signal Channel 7	6	Drive Enable Output 28
7	Digital Output 29	8	Digital Output 30
9	Digital Output 31	10	Single-ended Encoder Ch 12 A
11	Single-ended Encoder Ch 12 B	12	Single-ended Encoder Ch 12 Z
13	Single-ended Encoder Ch 13 A	14	Single-ended Encoder Ch 13 B
15	Single-ended Encoder Ch 13 Z	16	Single-ended Encoder Ch 14 A
17	Single-ended Encoder Ch 14 B	18	Single-ended Encoder Ch 14 Z
19	Single-ended Encoder Ch 15 A	20	Single-ended Encoder Ch 15 B
21	Single-ended Encoder Ch 15 Z	22	Digital Input 60
23	Digital Input 61	24	Digital Input 62
25	Drive Error Input 63	26	+5V

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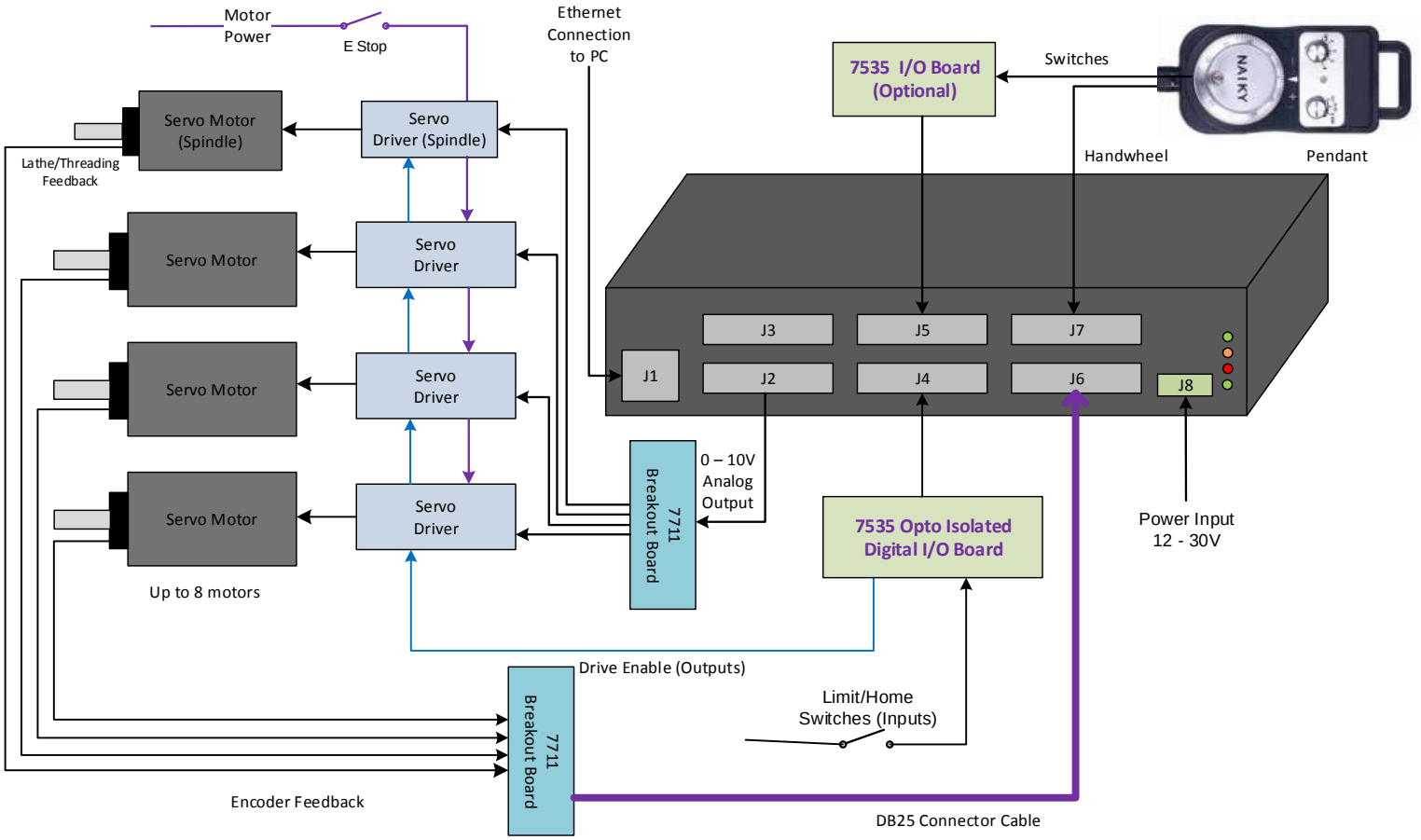
Installation Overview

The figure below shows a typical axis setup using Analog Servo amplifiers and quadrature encoder feedback. The 7711 and 7535 breakout boards may be connected on the DB25 connectors (J3 – J7) as shown in the figure.

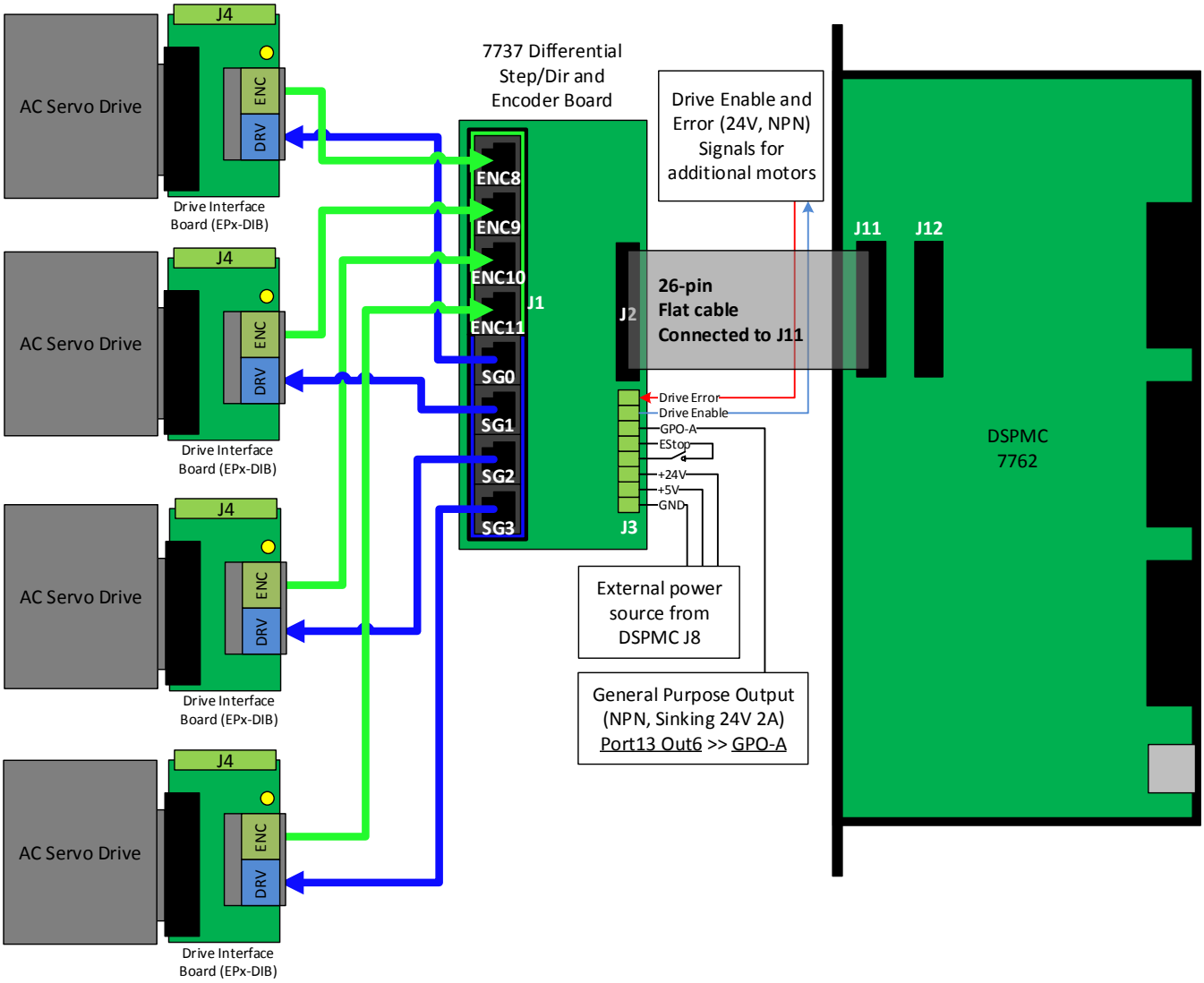
NOTE: Encoder cables must have adequate shielding and be properly grounded.

Analog Voltage Setup



Step and Direction Setup

The Step and Direction Setup with the DSPMC requires the use of the 7737 breakout board to access the Step/Dir outputs and additional encoder channels located on J11 and J12.



EtherCAT Setup

The EtherCAT Setup requires the 7729 EtherCAT Adapter Board to connect the DSPMC with an EtherCAT network. This effectively turns the DSPMC into an EtherCAT master capable of controlling multiple networked EtherCAT drives.